

Coal's High Tech Energy Future: Liquids and Gasification

Presentation to Utah Energy Forum,
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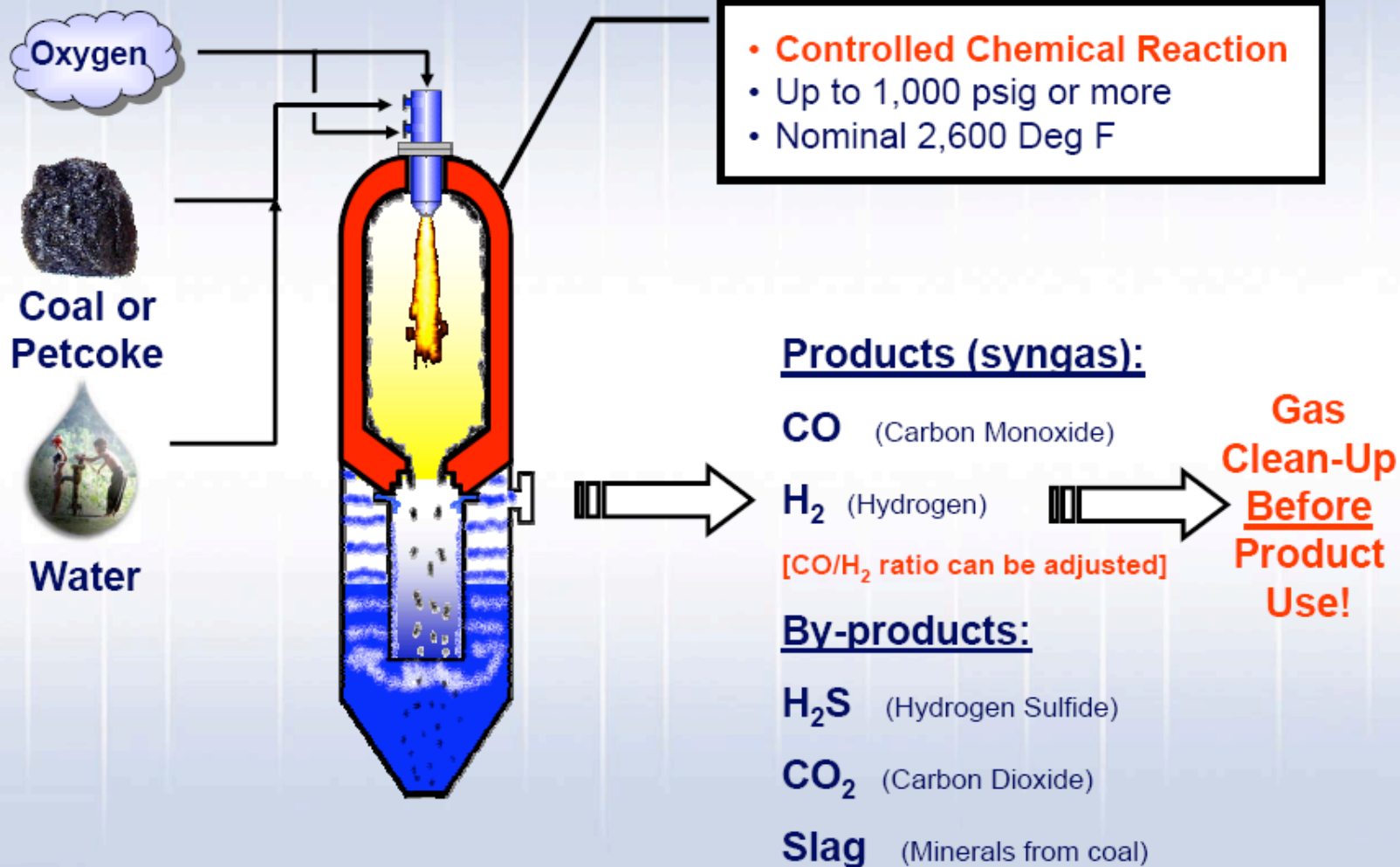
Overview

- ◆ **Gasification**
- ◆ **Coal-to-liquids (CTL)**
- ◆ **Integrated gasification combined cycle (IGCC)**
- ◆ **Comparison of technologies**
- ◆ **Industry status**
- ◆ **What is holding us back?**
- ◆ **C0₂ sequestration (EOR, ECBM)**

Gasification Basics

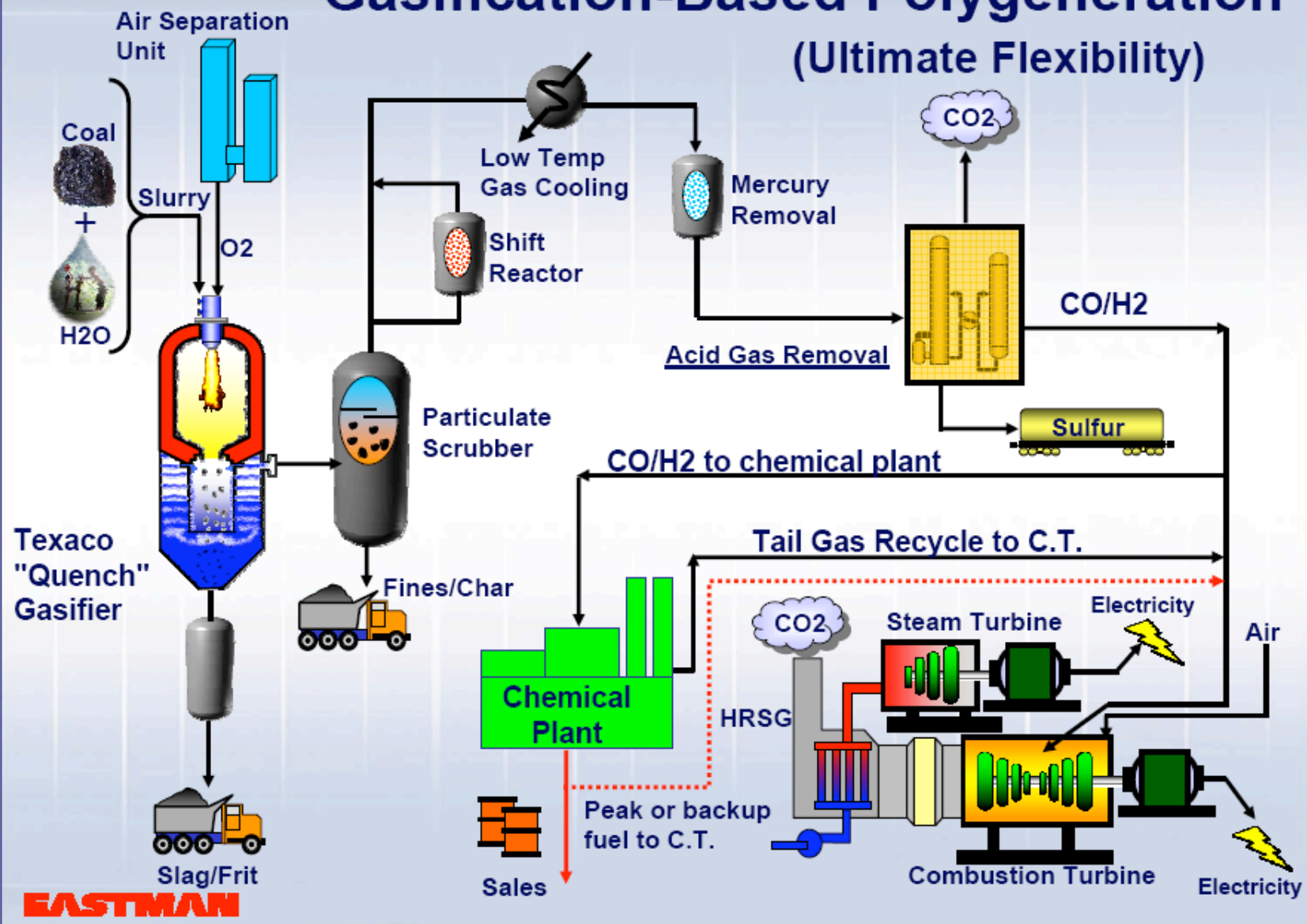
- ◆ **Gasification does not burn coal**
- ◆ **Coal is subject to hot steam and controlled amounts of air, or oxygen, under high temp and pressure in a reactor**
- ◆ **Carbon molecules break apart to produce hydrogen, carbon monoxide, and other gaseous compounds**

What is Gasification?



EASTMAN

Gasification-Based Polygeneration (Ultimate Flexibility)



Worldwide Gasifiers

Worldwide

- ◆ 117 gasification plants; 385 gasifiers
- ◆ 35 new facilities in design or construction
- ◆ trend is towards IGCC

USA

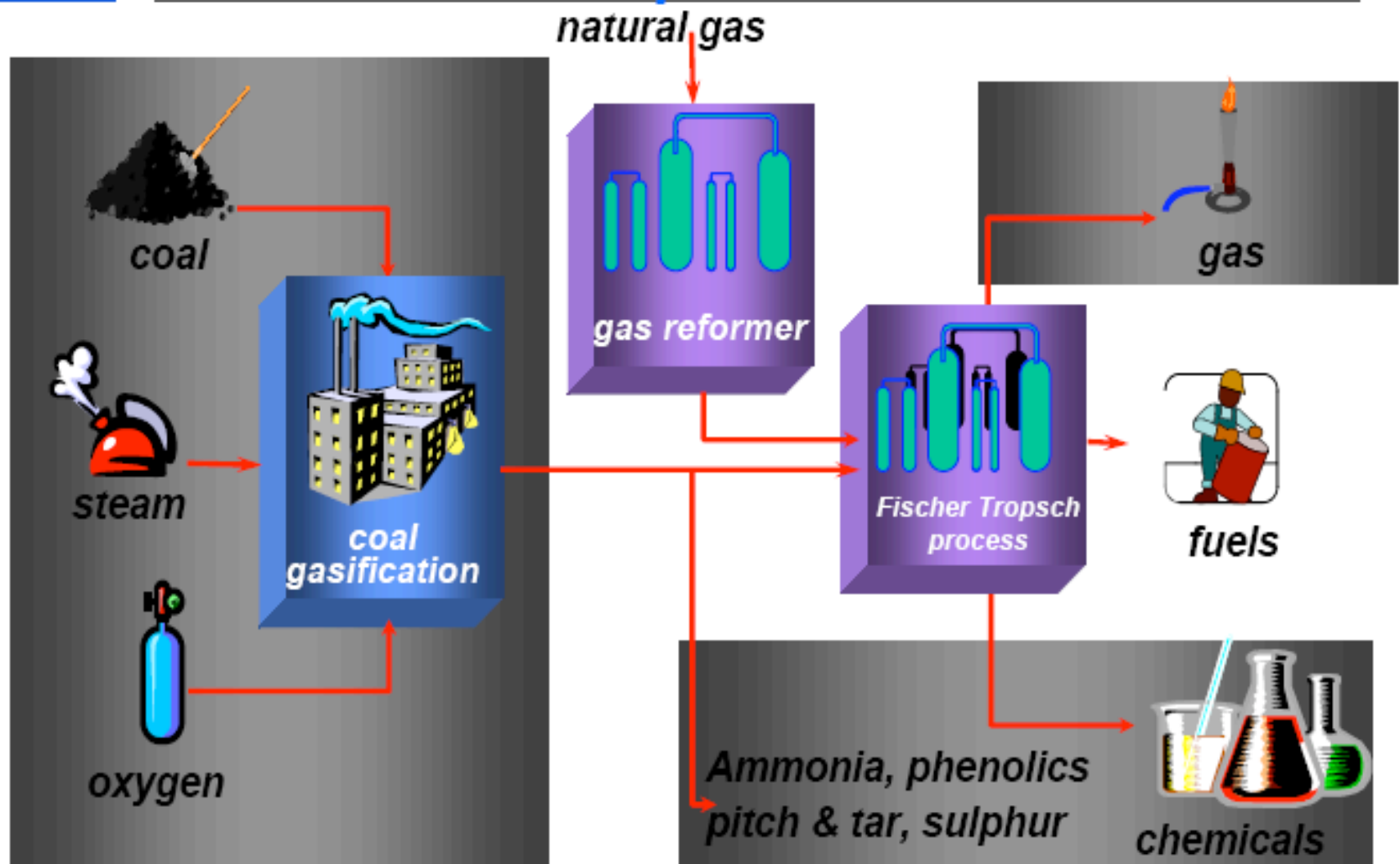
- ◆ 20 gasification plants
- ◆ 4 produce electricity
 - 2 use coal
 - Polk County IGCC
 - Wabash River IGCC

Sasol

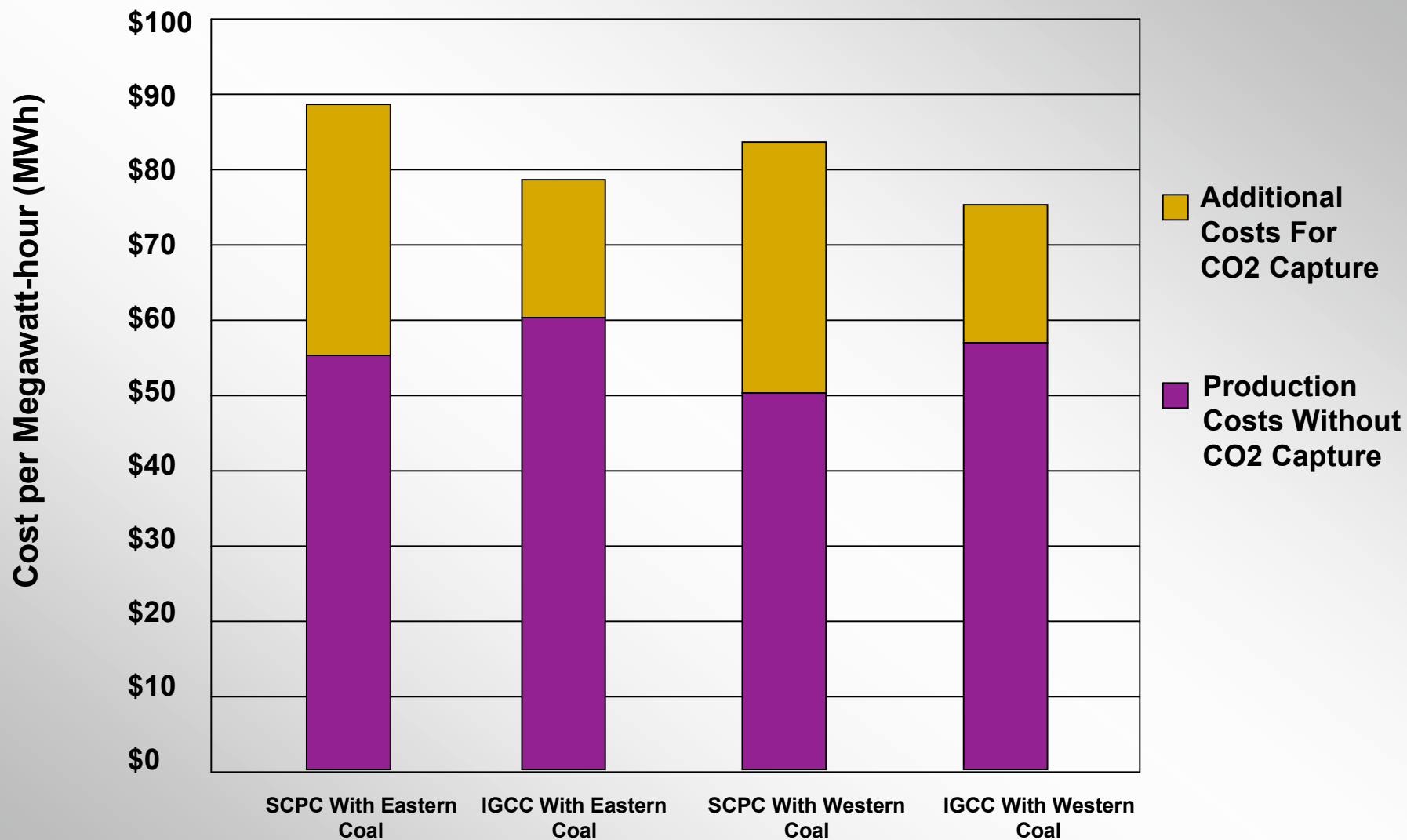
- ◆ **Three Sasol plants in South Africa account for about 30% of world gasifier capacity. They produce transportation fuels and chemicals from coal**
- ◆ **Equivalent of 150,000 bls/day chemicals and fuels including high quality diesel fuel**
- ◆ **Economic in US\$35 to \$40/bbl range**



Fischer Tropsch makes Sasol unique: GTL and CTL



IGCC and SCPC with and without Carbon Capture Technology



Source: Public Service Commission of Wisconsin Dept of Natural Resources
June 2006 EGCC Draft Report

Comparison of IGCC and SCPC

IGCC (disadvantages)

- Higher capital
- Higher operating
- Higher development costs
- Without CO₂ sequestration 7 to 14% higher costs/kWh

IGCC (advantages)

- Half NOx emissions
- Half Sox emissions
- Much better Hg removal
- Inert slag
- 30-50% less water use
- With CO₂ sequestration 9-15% lower costs/kWh
- Future potential for reducing costs as technology matures

Source: Nurula, R, Bechtel Power Corp and Lowe, E., Congress submission 2002

What's holding us back?

- ◆ **Costs – initial capital and operating**
- ◆ **Uncertainty on emissions regulations**
- ◆ **Uncertainty on future oil (< \$35/bbl) and natural gas prices (<\$4/MMBtu)**
- ◆ **Difficult to finance large, multi billion dollar projects**

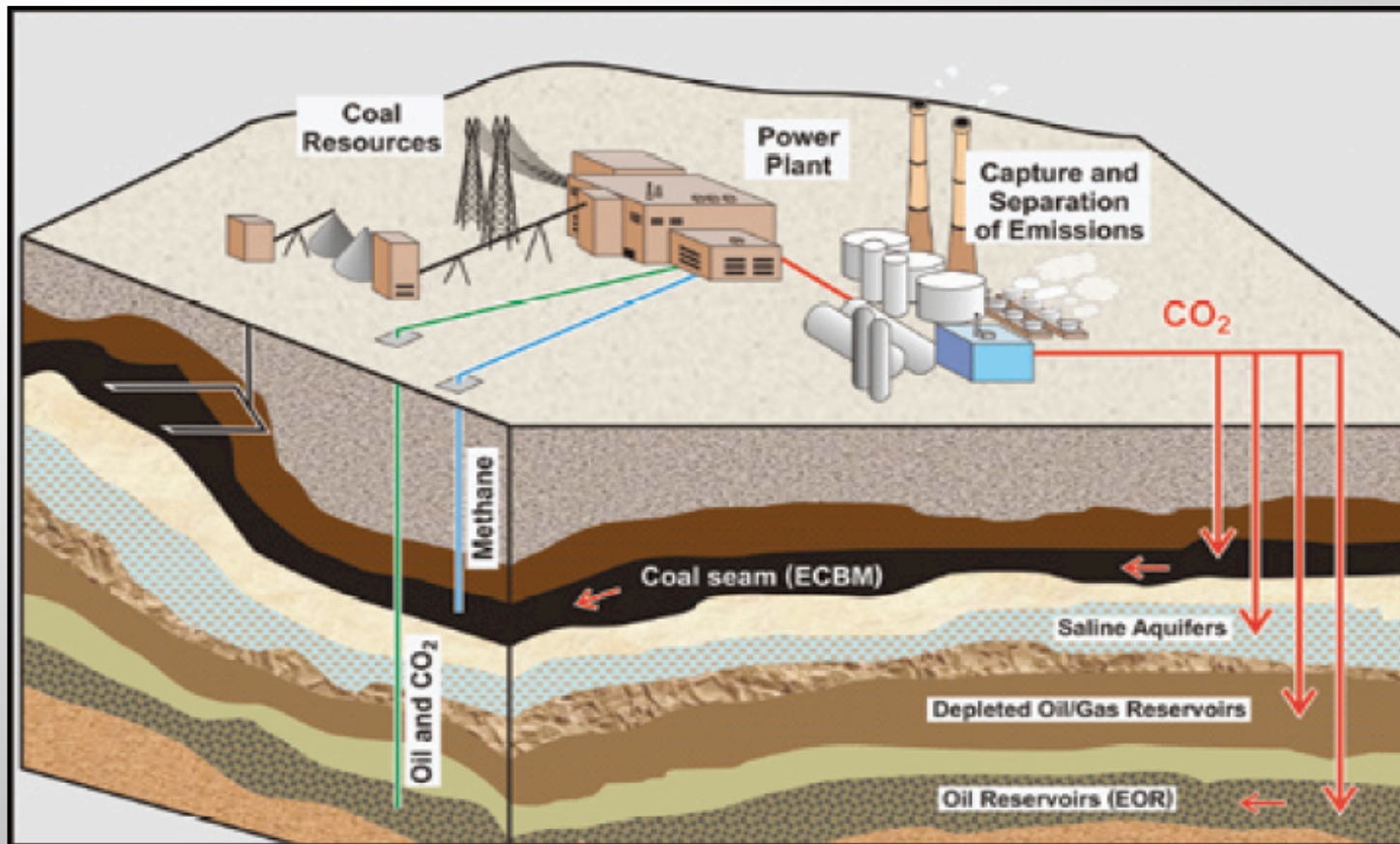
National Coal Council 2025 Projections

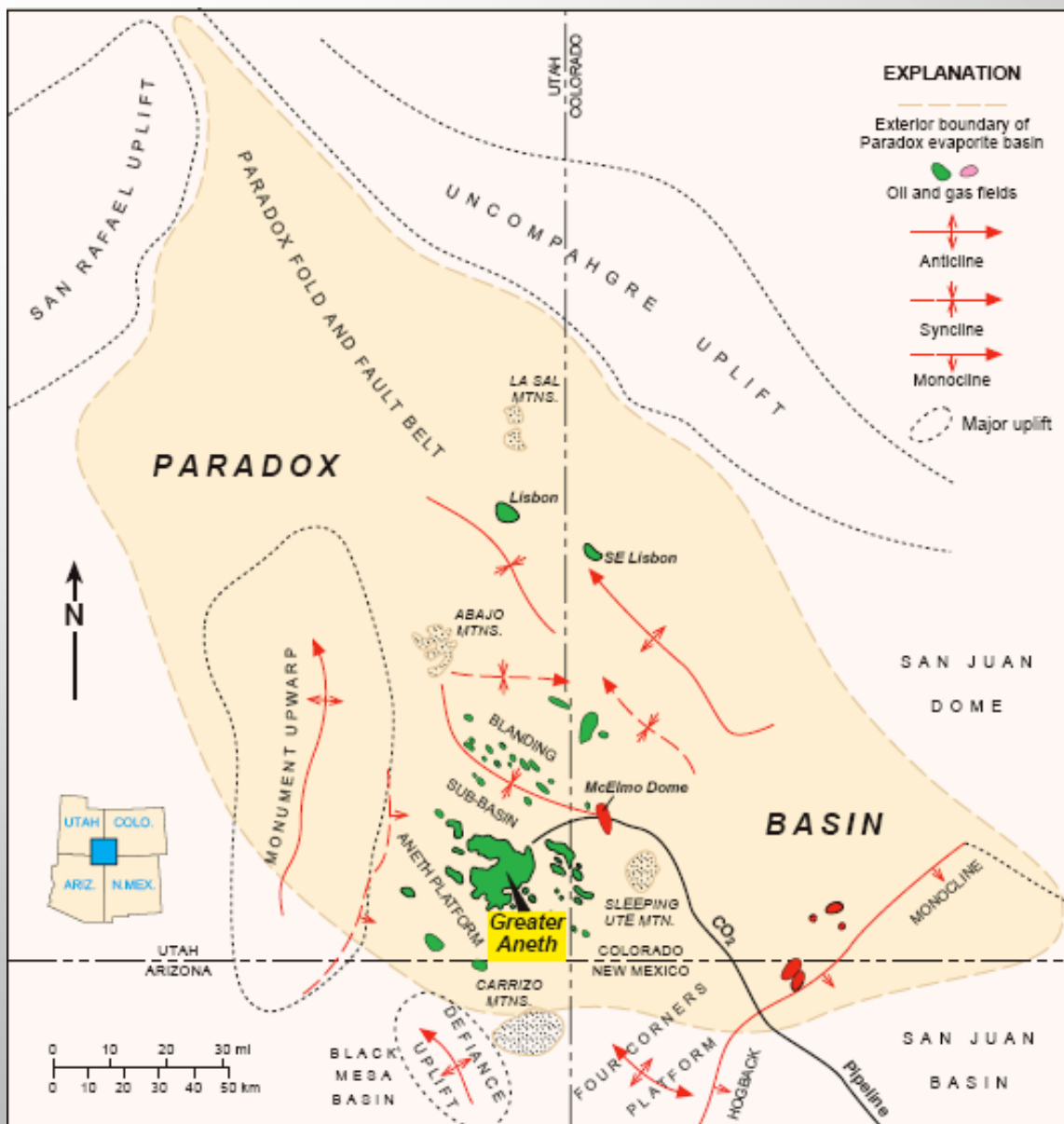
	Coal use (Mt/year)	Capex US\$ billions (2005)	Production
Coal-to-liquids	475	\$211	2.6 MMbbl/d (50% current US production)
Coal-to-gas	340	\$115	4.0Tcf/year (25% current US production)
Coal-to-electricity	375	150	100GW
Coal-to-hydrogen	60	\$27	10% H2 needs
Coal-to-ethanol	40	\$12	
Total	1,300	\$515	

What will accelerate gasification, IGCC and CTL investments?

- ◆ Government assistance (tax credits, loan guarantees, creative financing incentives etc E Policy Act 2005, Coal-to-liquids Promotion Act of 2006)
- ◆ Need more full scale projects (reduce capital and increase availability)
- ◆ CO₂ related legislation

CO₂ Sequestration

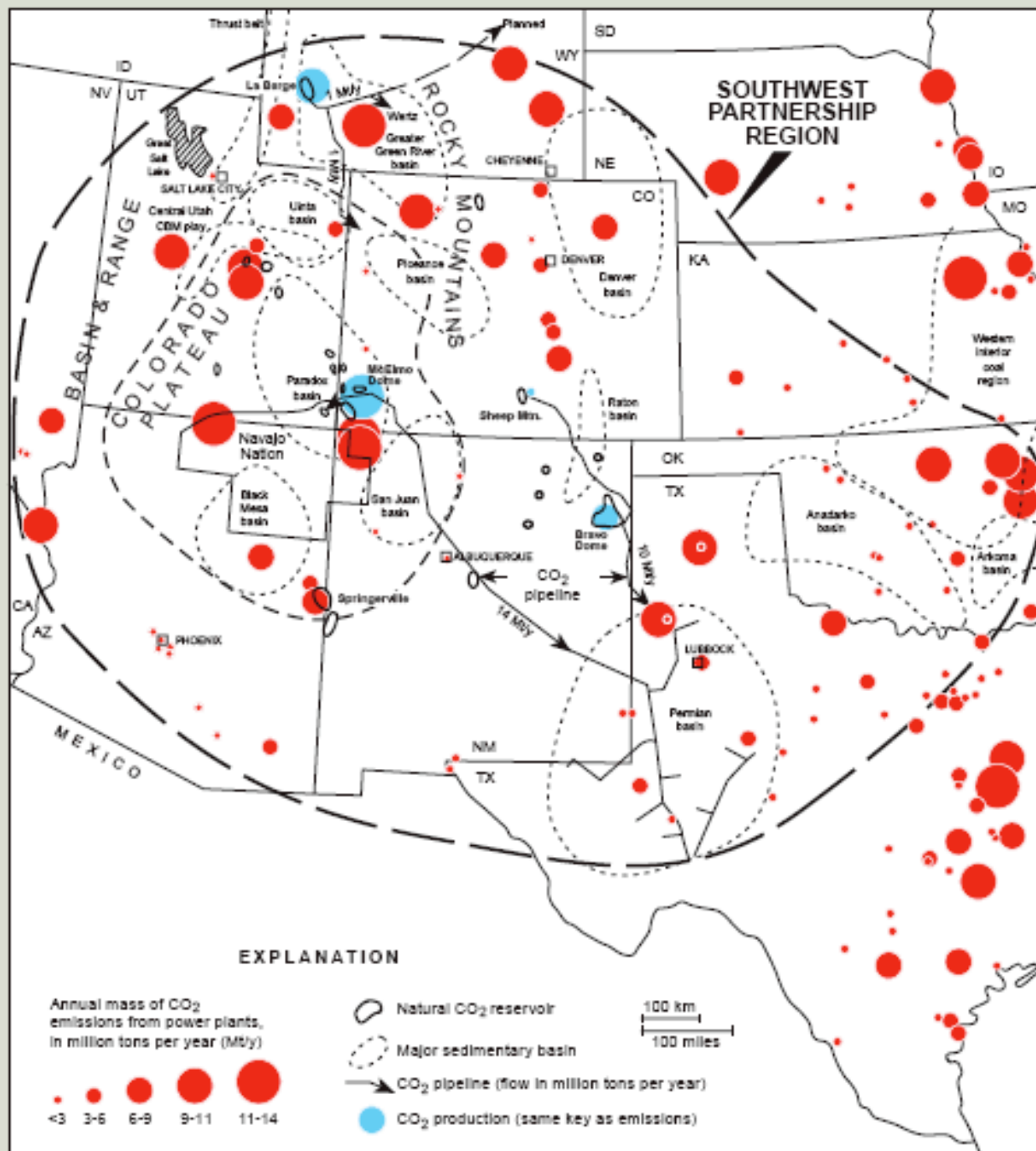




DOE CO₂ pilot project in SE Utah

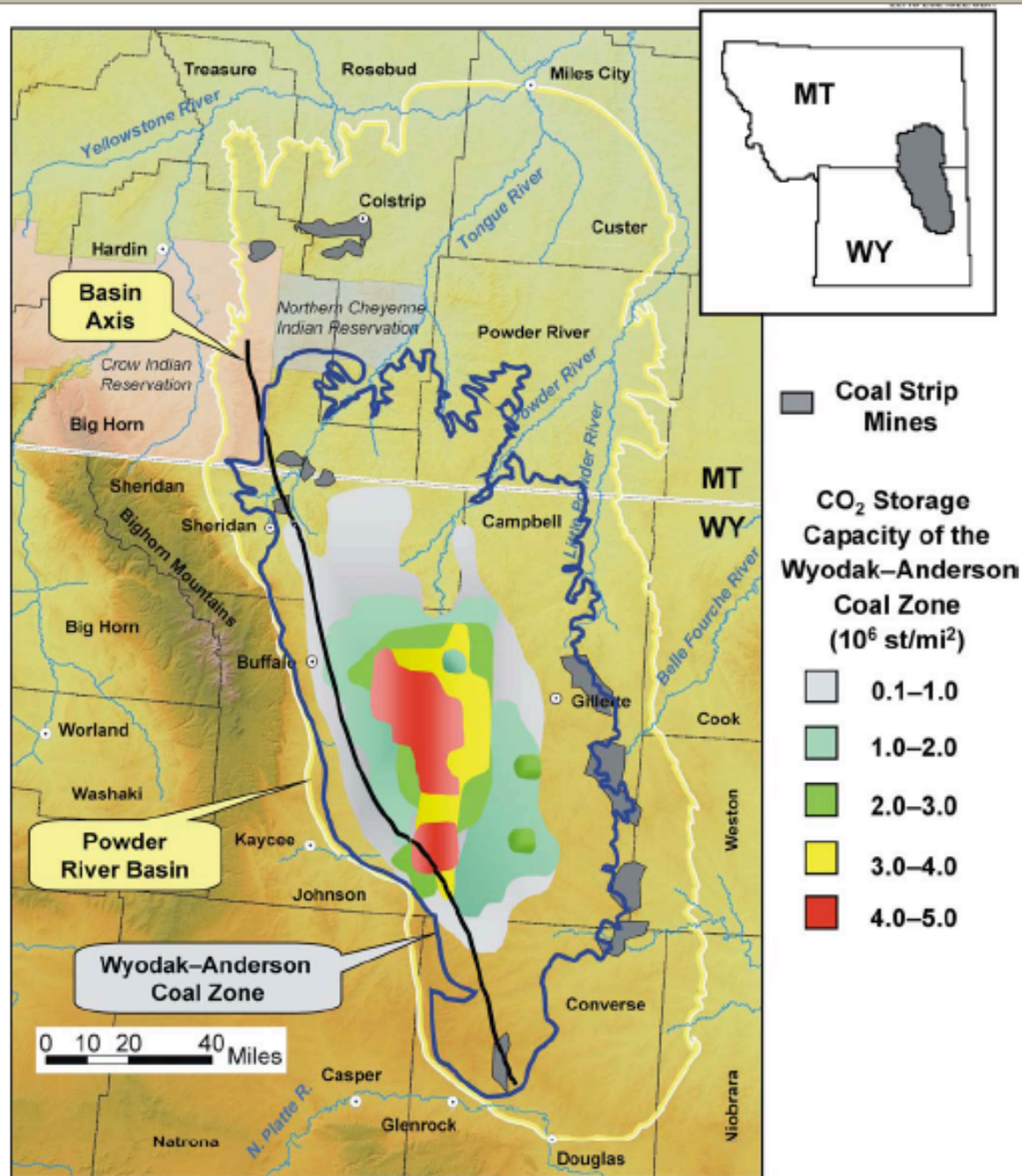
Anasazi field was chosen as the best candidate for a pilot CO₂ flood demonstration project after reservoir simulations were completed on both the Anasazi and Runway fields.

Western Power Plant CO₂ Emissions and CO₂ Production/Pipeline S



Source: Chidsey, Allis et al,
Utah Geological Survey 2003

ECBM Potential in Powder River Basin



Source: Nelson, C.R. et al, Plaine CO₂ Reduction Partnership

What does Utah have to offer?

- ◆ Reserve base of high quality coal
- ◆ History of coal mining and good labor force
- ◆ High rank coal (good for IGCC)
- ◆ Supportive state government
- ◆ Good sources for CO₂ sequestration including Enhance Oil Recovery (EOR) and Enhanced CBM (ECBM) sites



Summary

- ◆ **Gasification, CTL and ICGG similar technologies**
- ◆ **Proven technologies**
- ◆ **Higher cost, higher risk without incentives**
- ◆ **Energy security, local jobs,**
- ◆ **Look North Alberta oil sands**
- ◆ **What happens after 2008? McCain Clinton?**
- ◆ **Utah could be a preferred location for these technologies**